Practitioner's Docket No.: 789_071 *PATENT*

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of: Shuhei ISHIKAWA, Tsutomu MITSUI, Ken SUZUKI, Nobuaki NAKAYAMA, Hiroyuki TAKEUCHI and Seiji YASUI

Ser. No.: 09/913,353 Group Art Unit: 1775

Filed: August 13, 2001 Examiner: Turner, A.

Conf. No.: 8579

For: HEAT SINK MATERIAL AND METHOD OF PRODUCING THE SAME

#11 Ltr 3-14-03

Assistant Commissioner for Patents
Washington, DC 20231

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Tara L. Preston

Tara L. Preston

SUBMISSION OF NEW FORMAL DRAWINGS

Sir:

Attached please find new formal drawings of Figs. 3-5, 8, 16, 17, 19-21, 23, 24, 26-28, 30, 34, 38 and 40. The terms "impregnate," "impregnated," "impregnating" and "impregnation" have been changed to --infiltrate--, --infiltrated--, --infiltrating-- and --infiltration--, respectively, to correspond with the language used throughout the specification and claims.

The Examiner is requested to confirm receipt and entry of these new formal drawings.

Respectfully submitted,

February 26, 2003
Date

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FIG. 3

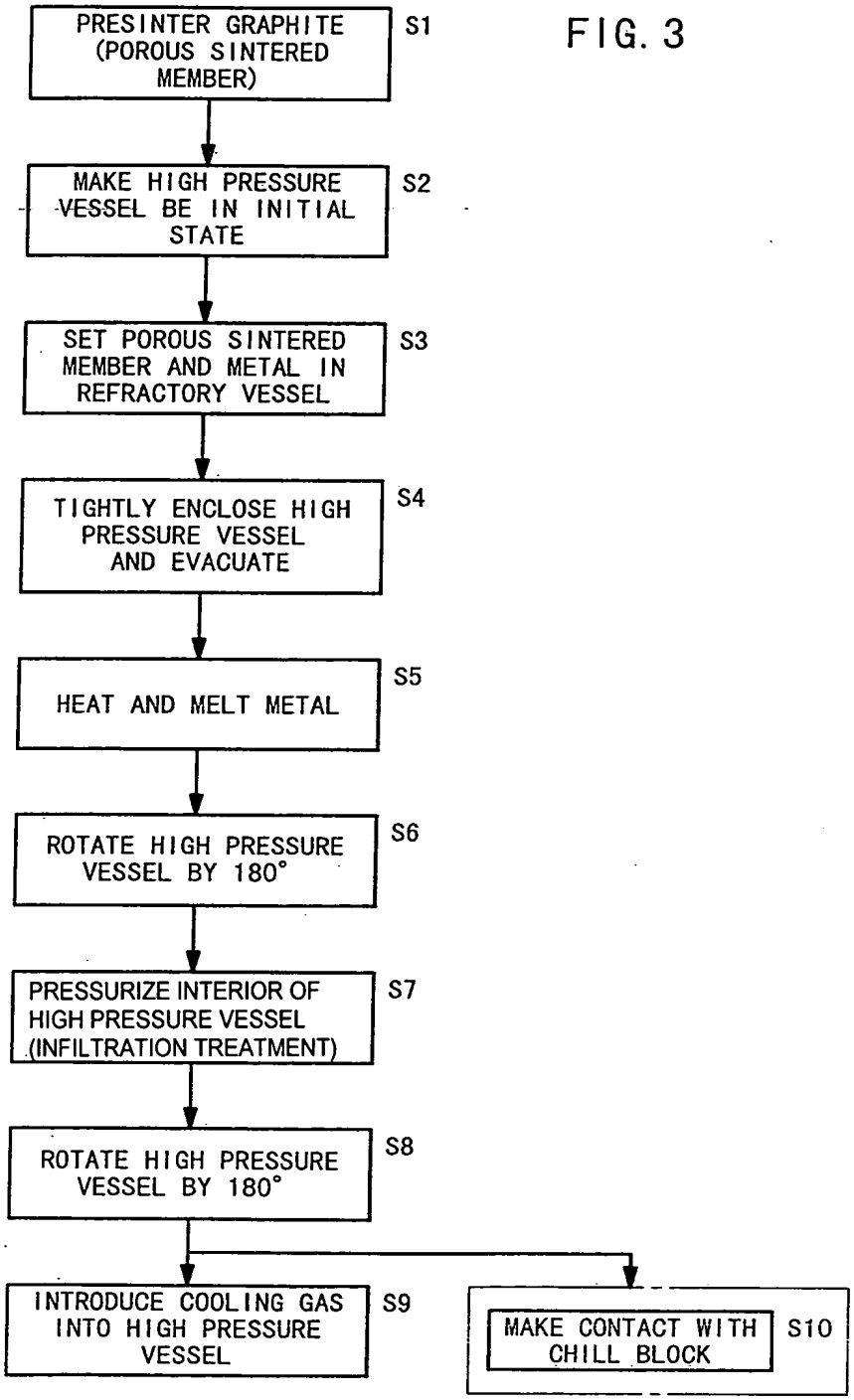

FIG. 4

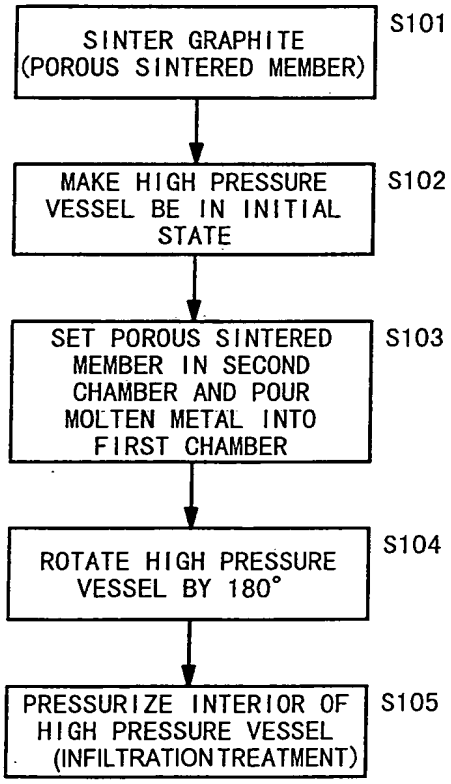

FIG. 5

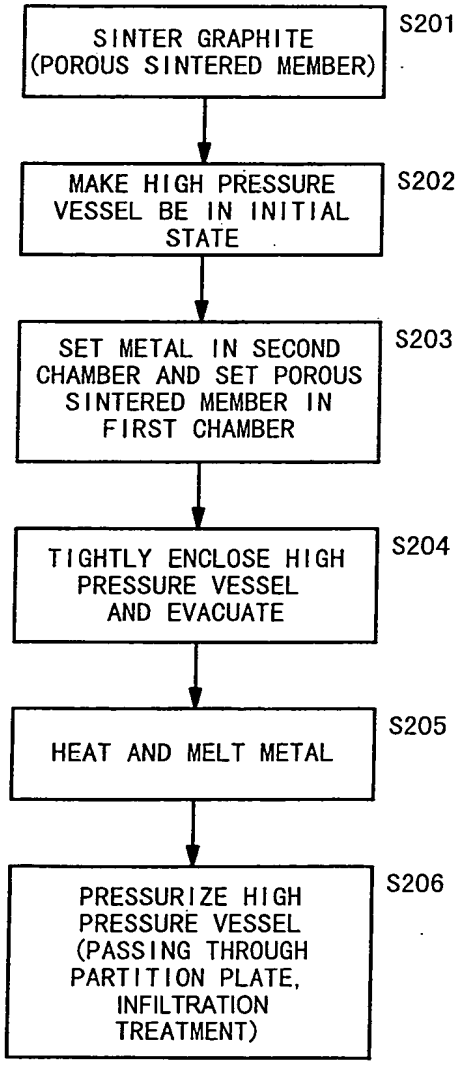

FIG. 8

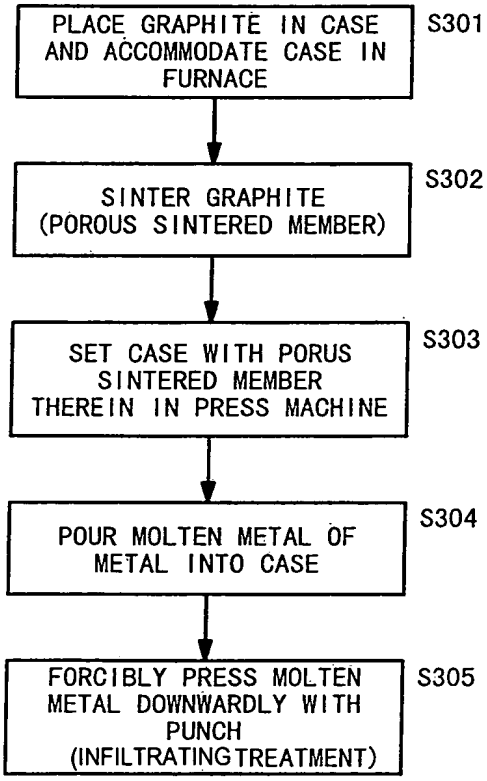

FIG. 16

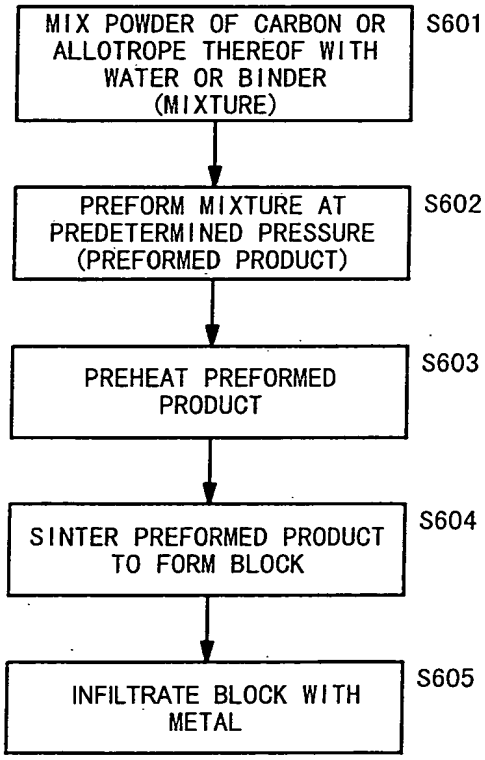

FIG. 17

SAMPLE	SIZE (mm)	TYPE OF POWDER	PARTICLE SIZE OF POWDER (μm)	FILLING METHOD	METAL	ADDED ELEMENT	AMOUNT OF ADDITION (wt%)	INFIL-TRATION METHOD	INFIL-TRATION PRESSURE (MPa)	COEFFICIENT OF THERMAL CONDUCTIVITY (W/mK)	COEFFICIENT OF THERMAL EXPANSION ($\times 10^{-6}$/K)	WATER RESISTANCE	EFFECT
PW-1	30 ×120 ×190	type -P	AVERAGE 120	NO PRESSUR-IZATION	Cu	Nb	0.001	PRESS	60.0	321	14.0	△	GENERA-TION OF CARBIDE
PW-2	30 ×120 ×191	type -S	AVERAGE 50	NO PRESSUR-IZATION	Cu	Nb	0.001	PRESS	60.0	325	13.5	△	GENERA-TION OF CARBIDE
PW-3	30 ×120 ×192	type -R	212-1180	NO PRESSUR-IZATION	Cu	Nb	0.001	PRESS	60.0	305	13.6	△	GENERA-TION OF CARBIDE
PW-4	30 ×120 ×193	type -P	AVERAGE 120	NO PRESSUR-IZATION	Cu	Nb	0.001	PRESS	60.0	321	14.0	△	GENERA-TION OF CARBIDE
PW-5	30 ×120 ×194	type -P	AVERAGE 120	PRESSUR-IZATION, 7MPa	Cu	Nb	0.001	PRESS	60.0	311	11.5	△	GENERA-TION OF CARBIDE
PW-6	30 ×120 ×195	type -P	AVERAGE 120	PRESSUR-IZATION, 25MPa	Cu	Nb	1.001	PRESS	60.0	301	9.5	△	GENERA-TION OF CARBIDE

FIG. 19

SAMPLE	SIZE (mm)	METAL	ELEMENT	AMOUNT OF ADDITION (wt%)	INFIL-TRATING METHOD	COEFFICIENT OF THERMAL CONDUCTIVITY (W/mK)		COEFFICIENT OF THERMAL EXPANSION ($\times 10^{-6}$/°C)		BENDING STRENGTH (MPa)		WATER RESISTANCE	EFFECT
						SUR-FACE	THICK-NESS	SUR-FACE	THICK-NESS	SUR-FACE	THICK-NESS		
p1-1	20x60x60	Al	NONE	NONE	PRESS	171	171	5.3	5.5	33.3	53.9	△	NONE
p1-2	20x60x60	Cu	NONE	NONE	PRESS	162	170	5.1	5.1	27.4	41.2	◎	NONE
p2-1	20x60x60	Cu	Bi	2	PRESS	168	178	5.0	5.1	28.4	45.1	◎	WETT-ABILITY
p2-2	20x60x60	Cu	Sb	0.5		178	186	5.0	5.1	27.4	41.2		
p2-3	20x60x60	Cu	Te	0.5		180	189	5.0	5.1	26.5	39.2		
p2-4	20x60x60	Cu	Te	2		172	178	4.9	5.0	25.5	38.2		
p2-5	20x60x60	Cu	Te, Bi	0.5, 0.5		169	176	5.0	5.0	26.5	39.2		
p2-6	20x60x60	Cu	Te, Pb	0.5, 2.0		172	185	5.0	5.0	27.4	41.2		
p3-1	20x60x60	Cu	Be	1	PRESS	184	204	5.0	5.0	34.3	57.8	△	GENERATION OF CARBIDE
p3-2	20x60x60	Cu	Cr	0.5		187	192	5.0	5.0	37.2	58.8		
p3-3	20x60x60	Cu	Mn	0.5		175	181	5.0	5.0	34.3	56.8		
p3-4	20x60x60	Cu	Nb	0.05		187	190	5.0	5.0	34.3	56.8		
p3-5	20x60x60	Cu	Zr	0.5		172	174	5.0	5.0	24.5	40.2		
p4-1	20x60x60	Cu	Te, Ni	0.5, 0.5	PRESS	165	177	5.0	5.0	27.4	45.1	○	COMBINED ADDITION
p5-1	20x60x60	Cu	NONE	NONE	GAS	170	188	5.0	5.0	27.4	41.2	◎	NONE
p6-1	10x85x180	Cu	Te	2	GAS	185	196	5.0	5.1	26.5	39.2	◎	WETT-ABILITY
p6-2	20x60x60	Cu	Te	2		192	204	5.0	5.0	28.4	42.1		

FIG. 20

SAMPLE	SIZE (mm)	METAL	ELEMENT	AMOUNT OF ADDITION (wt%)	INFIL-TRATING METHOD	COEFFICIENT OF THERMAL CONDUCTIVITY (W/mK)		COEFFICIENT OF THERMAL EXPANSION ($\times 10^{-6}$/°C)		BENDING STRENGTH (MPa)		WATER RESISTANCE	EFFECT
						SUR-FACE	THICK-NESS	SUR-FACE	THICK-NESS	SUR-FACE	THICK-NESS		
m1-1	20x60x60	Al	NONE	NONE	PRESS	161	187	4.5	5.6	34.3	56.8	△	NONE
m1-2	20x60x60	Cu	NONE	NONE	PRESS	145	181	4.5	5.1	28.4	42.1	◎	NONE
m2-1	20x60x60	Cu	Te	0.50	PRESS	168	199	4.5	5.1	26.5	39.2	◎	WETT-ABILITY
m3-1	20x60x60	Cu	Be	1.00	PRESS	184	213	4.5	5.1	36.3	59.8	△	GENERATION OF CARBIDE
m3-2	20x60x60	Cu	Cr	0.50		170	193	4.5	5.1	37.2	60.8		
m3-3	20x60x60	Cu	Mn	0.50		165	192	4.5	5.1	35.3	57.8		
m3-4	20x120x190	Cu	Nb	0.05		162	192	4.5	5.1	35.3	57.8		
m3-5	20x60x60	Cu	Nb	0.05		169	207	4.5	5.1	35.3	57.8		
m3-6	20x60x60	Cu	Zr	0.50		158	182	4.5	5.1	32.3	52.9		
m5-1	20x60x60	Cu	NONE	NONE	GAS	166	198	4.5	5.1	25.5	38.2	◎	NONE

FIG. 21

SAMPLE	SIZE (mm)	METAL	ADDITIVE ELEMENT	AMOUNT OF ADDITION (wt%)	INFILTRATING METHOD	INFILTRATION PRESSURE (MPa)	COEFFICIENT OF THERMAL CONDUCTIVITY (W/mK)		COEFFICIENT OF THERMAL EXPANSION ($\times 10^{-6}$/K)		BENDING STRENGTH (MPa)		COMPRESSIVE STRENGTH (MPa)		WATER RESISTANCE	EFFECT
									SURFACE	THICKNESS	SURFACE	THICKNESS	SURFACE	THICKNESS		
n1-1	20×60×60	Al	NONE	NONE	PRESS	26.7	156	311	5.5	6.0	31.4	51.9	46.1	51.0	△	NONE
n1-4	20×120×190	Al	NONE	NONE	PRESS	60.0	185	350	5.5	6.5					△	NONE
n1-2	20×60×60	Cu	NONE	NONE	PRESS	26.7	150	310	3.8	4.5	26.5	39.2			◎	NONE
n1-3	20×120×190	Cu	NONE	NONE	PRESS	26.7	147	268	3.9	4.5	26.5	39.2			◎	NONE
n2-1	20×60×60	Cu	Te	0.500	PRESS	26.7	190	351	3.8	4.5	26.5	39.2			◎	WETTABILITY
n3-1	20×60×60	Cu	Be	1.000	PRESS	26.7	183	341	3.8	4.5	38.2	62.7			△	GENERATION OF CARBIDE
n3-2	20×120×190	Cu	Be	1.000	PRESS	156.1	189	342	4.0	4.6	37.2	61.7			△	
n3-3	20×60×60	Cu	Cr	0.500	PRESS	26.7	180	320	3.8	4.5	36.3	59.8			△	
n3-4	20×60×60	Cu	Mn	0.500	PRESS	26.7	176	330	3.8	4.5	34.3	55.9	42.1	48.0	△	
n3-5	20×60×60	Cu	Nb	0.050	PRESS	156.1	198	336	3.8	4.5	35.3	57.8			△	
n3-6	20×120×190	Cu	Nb	0.050	PRESS	26.7	167	309	3.8	4.5	35.3	57.8			△	
n3-7	20×60×60	Cu	Zr	0.500	PRESS	26.7	158	312	3.8	4.5	34.3	56.8			△	
n3-8	20×120×190	Cu	Nb	0.001	PRESS	43.3	182	352	4.5	3.0			40.2	51.9	△	
n3-9	20×120×190	Cu	Nb	0.001	PRESS	60.0	182	363	4.0	3.0			42.1	51.9	△	
n3-10	20×120×190	Cu	Nb	1.100	PRESS	60.0	196	359	4.0	2.5			51.0	58.8	△	
n3-11	20×120×190	Cu	Be	1.900	PRESS	60.0	186	366	4.5	3.5			57.8	64.7	△	
n3-12	20×120×190	Cu	Ni, Sn	9.4, 6.7	PRESS	60.0	190	343					51.9	51.0	◎	COMBINED ADDITION
n3-13	20×120×190	Cu	Ni, Si, P	1.0, 0.23, 0.04		60.0	190	353					48.0	51.9	○	
n3-14	20×120×190	Cu	Mn	4.180	PRESS	60.0	181	352					51.0	54.9	△	GENERATION OF CARBIDE
n3-15	20×120×190	Cu	Cr	2.870	PRESS	60.0	195	387					48.0	51.9	△	
n3-16	20×120×190	Cu	Zr	4.490	PRESS	60.0	207	367					53.9	63.7	△	
n3-17	20×120×190	Cu	Si	11.300	PRESS	26.7	157	333					53.9	60.8	◎	EXPANSION OF SOLID-LIQUID RANGE
n3-18	20×120×190	Cu	Si	10.900	PRESS	60.0	159	316					56.8	68.6	◎	
n3-19	20×120×190	Cu	Si	5.170	PRESS	153.0	165	343					52.9	62.7	◎	
n3-20	20×120×190	Cu	Si	5.300	PRESS	43.3	163	325					54.9	60.8	◎	
n5-1	20×60×60	Cu	NONE	NONE	GAS	26.7	170	320	3.8	4.5	26.5	39.2			◎	NONE
n7-1	20×120×190	Al	Be	2.000	PRESS	60.0	177	332	5.0	6.5			57.8	62.7	△	GENERATION OF CARBIDE
n7-2	20×120×190	Al	Si	5.000	PRESS	60.0	169	329	5.0	6.5			50.0	61.7	◎	EXPANSION OF SOLID-LIQUID RANGE
n7-3	20×120×190	Al	Si	12.000	PRESS	60.0	181	327	5.0	6.5			56.8	68.6	◎	

FIG. 23

SAMPLE	SIZE (mm)	METAL	ELEMENT	AMOUNT OF ADDITION (wt%)	INFIL-TRATING METHOD	COEFFICIENT OF THERMAL CONDUCTIVITY (W/mK)		COEFFICIENT OF THERMAL EXPANSION ($\times 10^{-6}$/°C)		BENDING STRENGTH (MPa)		WATER RESISTANCE	EFFECT
						SUR-FACE	THICK-NESS	SUR-FACE	THICK-NESS	SUR-FACE	THICK-NESS		
p1-2	20x60x60	Cu	NONE	NONE	PRESS	162	170	5.1	5.1	27.4	41.2	◎	NONE
p5-1	20x60x60				GAS	170	188	5.0	5.0	27.4	41.2		
p2-4	20x60x60	Cu	Te	2	PRESS	172	178	4.9	5.0	25.5	38.2	◎	WETT-ABILITY
p6-2	20x60x60	Cu	Te	2	GAS	192	204	5.0	5.0	28.4	42.1		
m1-2	20x60x60	Cu	NONE	NONE	PRESS	145	181	4.5	5.1	28.4	42.1	◎	NONE
m5-1	20x60x60				GAS	166	198	4.5	5.1	25.5	38.2		
n1-2	20x60x60	Cu	NONE	NONE	PRESS	150	310	3.8	4.5	26.5	39.2	◎	NONE
n5-1	20x60x60	Cu			GAS	170	320	3.8	4.5	26.5	39.2		

FIG. 24

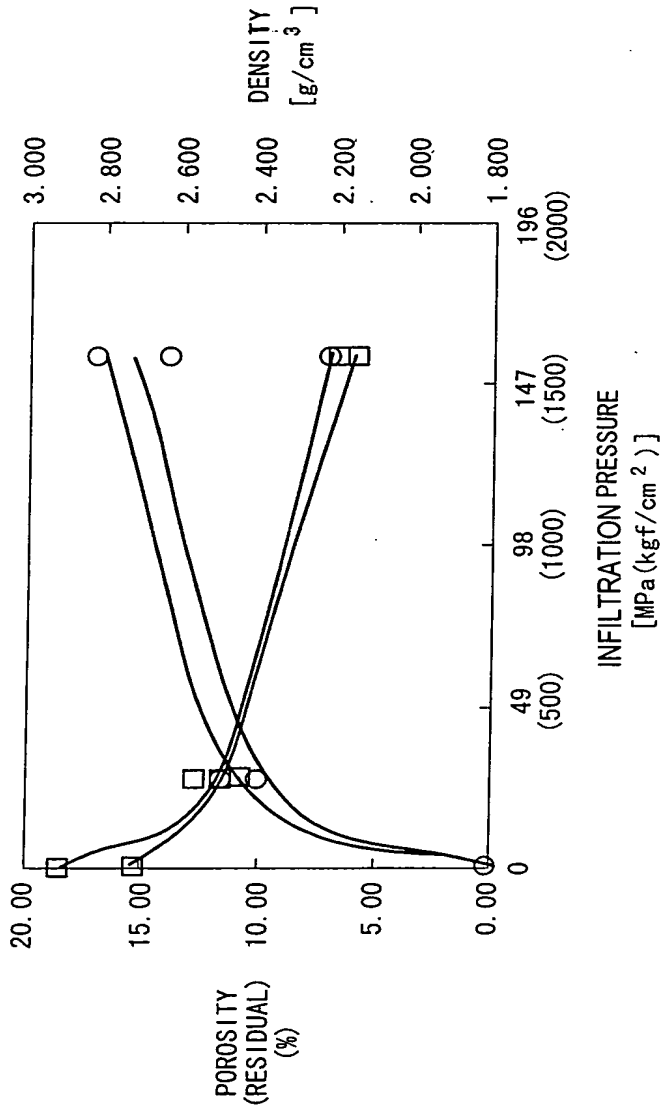

FIG. 26

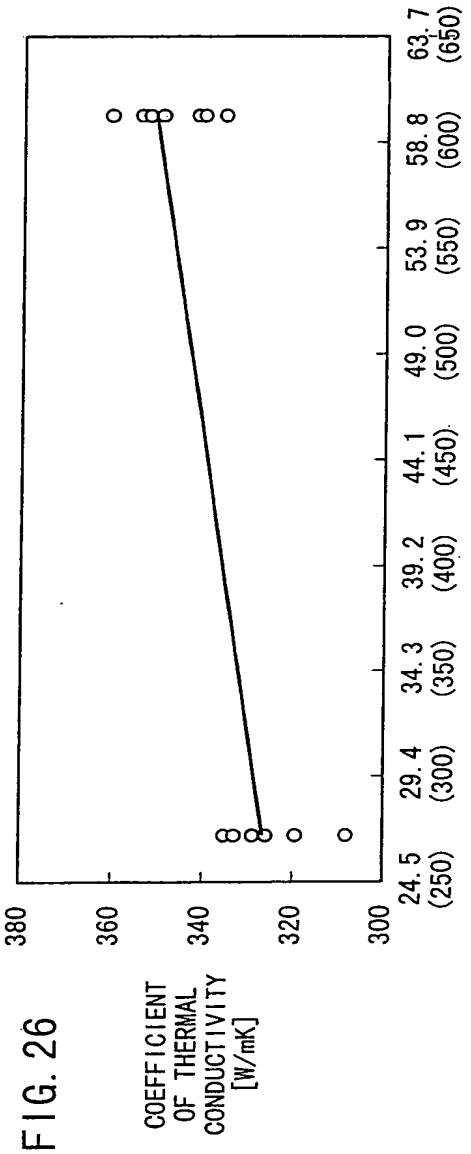

FIG. 27

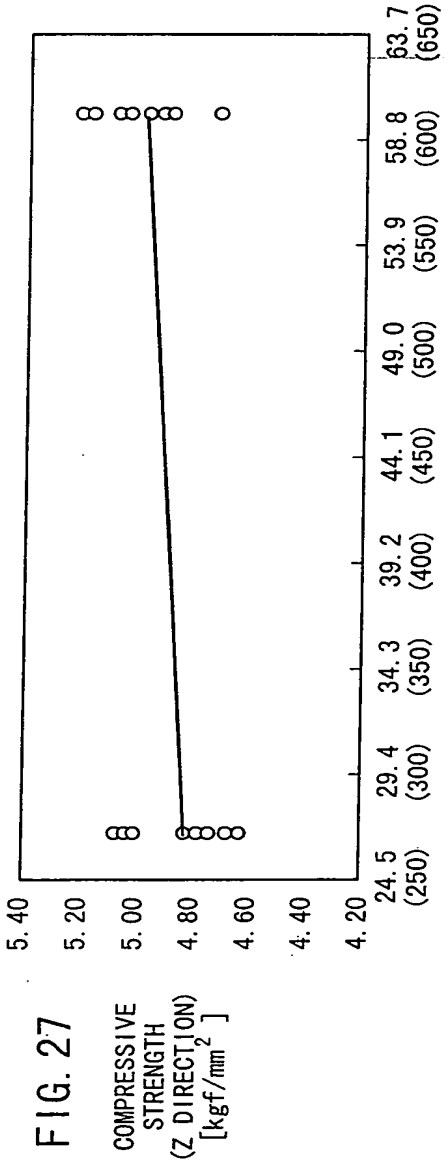

FIG. 28

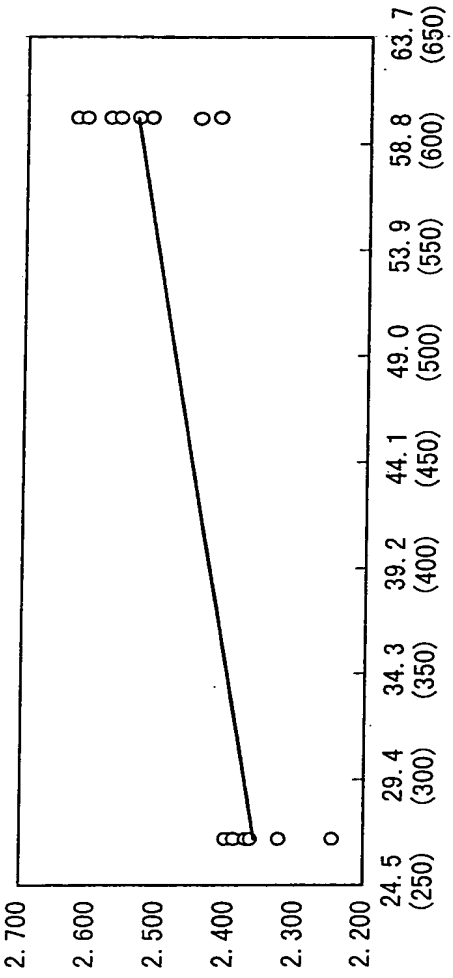

FIG. 30

No.	POROSITY [%]	PORE DIAMETER [μm]	Ni PLATING	Si INFIL-TRATION	INFILTRATION TEMPERATURE [°C]	PRESSURIZATION [MPa(kgf/cm²)]	PRESSURIZATION TIME [sec]	COOLING SPEED [°C/min]	REACTION OF Si/Cu	INFIL-TRATION
SAMPLE1	35	70	ABSENT	ABSENT	1130	0.78(8)	60	260	△	△
SAMPLE2	44	22	ABSENT	ABSENT	1130	7.84(80)	20	900	○	◎
SAMPLE3	59	42	ABSENT	PRESENT	1130	11.8(120)	10	480	◎	◎
SAMPLE4	15	5	PRESENT	ABSENT	1130	23.5(240)	10	900	◎	○
SAMPLE5	59	42	ABSENT	PRESENT	1180	0.78(8)	60	900	△	△
SAMPLE6	15	5	ABSENT	ABSENT	1180	3.92(40)	20	480	○	△
SAMPLE7	59	42	ABSENT	PRESENT	1180	11.8(120)	10	900	◎	◎
SAMPLE8	44	22	ABSENT	ABSENT	1180	23.5(240)	10	620	◎	◎
SAMPLE9	44	22	ABSENT	PRESENT	1230	0.78(8)	20	480	○	△
SAMPLE10	59	42	PRESENT	ABSENT	1230	3.92(40)	35	790	○	○
SAMPLE11	35	70	ABSENT	ABSENT	1230	7.84(80)	100	620	◎	◎
SAMPLE12	44	22	ABSENT	PRESENT	1230	23.5(240)	5	620	◎	◎
SAMPLE13	59	42	ABSENT	ABSENT	1280	3.92(40)	50	790	○	○
SAMPLE14	35	70	ABSENT	ABSENT	1280	7.84(80)	35	480	△	◎
SAMPLE15	44	22	PRESENT	ABSENT	1280	7.84(80)	5	620	○	◎
SAMPLE16	59	42	ABSENT	PRESENT	1280	11.8(120)	10	790	○	◎
SAMPLE17	20	21	ABSENT	ABSENT	1150	156.1	3	900	◎	◎
SAMPLE18	20	19	ABSENT	ABSENT	1150	156.1	5	900	◎	◎
SAMPLE19	20	23	ABSENT	ABSENT	1140	69.3	5	900	◎	◎
SAMPLE20	20	22	ABSENT	ABSENT	1145	26.7	7	900	◎	◎

NOTES REACTION of Si/Cu: ◎NO REACTION ○SLIGHT REACTION △STRONG REACTION
INFILTRATION OF Cu : ◎GOOD INFILTRATION ○SLIGHTLY INSUFFICIENT INFILTRATION
△INSUFFICIENT INFILTRATION

FIG. 34

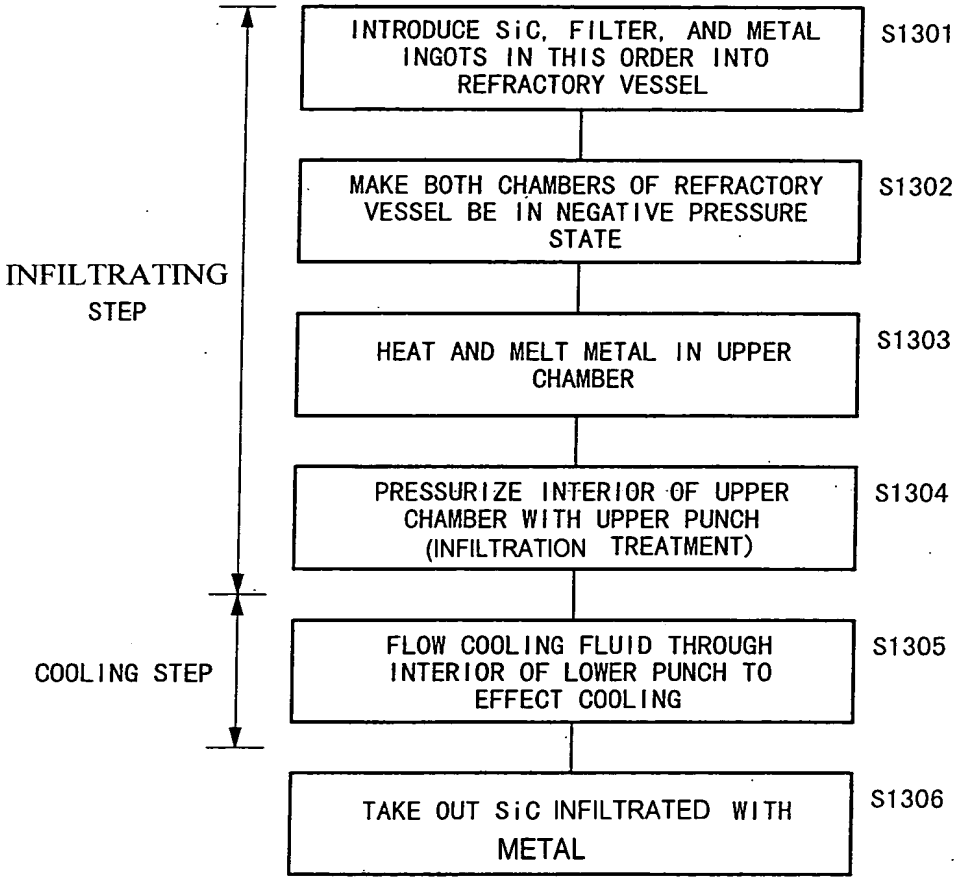

FIG. 38

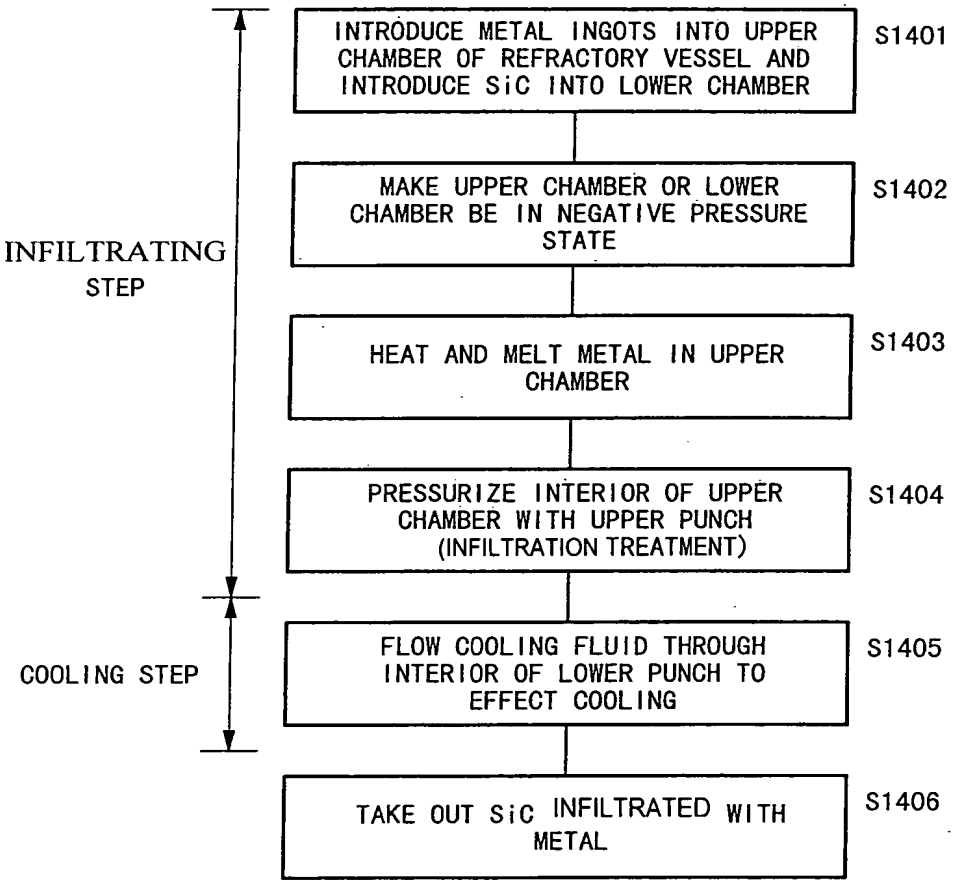

FIG. 40